In re application of	:	Schuegraf
Appl. No.	:	09/770,540
Filed	:	January 26, 2001
For	:	RUGGED METAL ELECTRODES FOR METAL-INSULATOR-METAL CAPACITORS
Examiner	:	Laura M. Schillinger
Art Unit	:	2813

I hereby certify that this correspondence and all marked attachments are being deposited with the United States Postal Service as first-class mail in an envelope addressed to: Mail Stop Appeal Brief - Patents, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on

September 21, 2004
(Date)

Adeel S. Akhtar, Reg. No. 41,394

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Transmitted herewith in triplicate is an Appellants' Brief to the Board of Patent Appeals:

(X) Fee for filing brief in the amount of $330 is enclosed.

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(X) If applicant has not requested a sufficient extension of time and/or has not paid any other fee in a sufficient amount to prevent the abandonment of this application, please consider this as a Request for an Extension for the required time period and/or authorization to charge our Deposit Account No. 11-1410 for any fee which may be due. Please credit any overpayment to Deposit Account No. 11-1410.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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CERTIFICATE OF MAILING

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Adeel S. Akhtar, Reg. No. 41,394

ON APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES APPELLANTS' BRIEF

Mail Stop Appeal Brief -- Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This Appeal Brief relates to an appeal to the Board of Patent Appeals and Interferences of the final rejection set forth in a final Office Action mailed March 24, 2004 in the above-captioned application.

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is the assignee of this application, Micron Technology, Inc.

II. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any related appeals or interferences.

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III. STATUS OF THE CLAIMS

The application was originally filed with Claims 1-20. By Preliminary Amendment, Claims 13-19 were cancelled and Claims 21-24 added. Claims 1-5 were restricted from prosecution and withdrawn, but have never been cancelled during the course of prosecution.

Through subsequent prosecution, after an indication of allowance of Claims 6-12, Appellant cancelled Claims 20-24. However, allowability of Claims 6-12 was subsequently withdrawn in view of a new reference, such that Appellant attempted to reintroduce the cancelled claims in the form of new Claims 25-30. While that Amendment was entered by the Examiner, the Examiner withdrew from consideration Claims 25-28, despite the fact that they were substantially identical (albeit somewhat narrowed) to originally examined Claims 20-24.

Thus, by Final Office Action of March 24, 2004, the Examiner finally rejected Claims 6-12 and 29-30, while Claims 1-5 and 25-28 were withdrawn from consideration.

Claims 6-12 and 29-30 are before the Board as finally rejected. Appellant also appeals the withdrawal from consideration of Claims 25-27 but does not object in the present Appeal to the withdrawal of Claims 1-5 and 28.

The claims that are the subject of the present appeal, including finally rejected Claims 6-12 and 29-30 and withdrawn Claims 25-27, are reproduced and attached as Appendix A.

IV. STATUS OF AMENDMENTS

All offered amendments have been entered. The claims appear before the Board as they were finally rejected (Claims 6-12 and 29-30) or withdrawn by the Examiner from prosecution (Claims 25-27), and are attached hereto as Appendix A.

V. SUMMARY OF THE INVENTION

As described in the Background of the Invention of the application as filed, one method of increasing the capacitance of capacitors used in memory cells, such as dynamic random access memory (DRAM), is to increase the surface area of memory cell plates, such as by utilizing electrodes having a textured surface morphology, and another method is to employ capacitor dielectric materials having higher dielectric constants. *See* Application at p. 1, ll. 27-30. However, due to their reactivity and complex processing, high dielectric constant materials are

generally not compatible with traditional polysilicon electrodes, such that efforts have been directed towards developing suitable metal electrodes for use with high dielectrics. *See* Application at p. 2, ll. 9-12.

The present application presents a method in which a high surface area electrode can be produced in a metal form that can be resistant to high dielectric materials. The method includes first forming a textured silicon structure and subsequently replacing silicon atoms in the textured structure with metal atoms. Application at p. 3, ll. 6-9. In an illustrated embodiment, the electrode is first formed as an amorphous or polycrystalline structure that is annealed to form a silicon surface with a textured surface morphology. A metal substitution process exposes the textured silicon to a refractory metal-halide complex, such as WF_6, thus producing the rugged metal surface. Application at p. 3, ll. 9-14.

The detailed description and figures illustrate the preferred embodiment of the invention. Figure 1 illustrates a rugged silicon electrode 24 having a textured or rugged surface region 26. Application at p. 5, ll. 7-9. In an exemplary process for forming this rough or rugged surface 26 results in a morphology which is bulbous and includes relatively large polycrystallites, referred to as Hemispherically Grained Silicon (HSG). Application at p. 5, ll. 29-31. This rugged silicon surface 26 is subsequently converted to a rugged metal surface by a substitution reaction whereby a refractory metal-halide complex is exposed to the silicon surface under the appropriate conditions and metal atoms replace the silicon atoms in the rugged structure. *See* Application at p. 6, ll. 14-27.

The appealed claims reflect this inventive sequence. For example, independent Claim 6 recites forming a silicon electrode structure, making the silicon electrode structure rugged, and, ***after making the silicon electrode rugged***, replacing the silicon in the rugged silicon electrode structure with a metal, thereby forming a rugged metal electrode. Similarly, independent Claim 25 (withdrawn) recites forming a rugged silicon electrode structure and forming a metal electrode having a rugged surface on the substrate ***after forming the rugged silicon electrode*** by replacing silicon in the rugged silicon electrode structure with metal.

VI. ISSUES BEFORE THE BOARD

This Appeal turns on two issues:

(1) whether the pending Claims 6-12 and 29-30 are properly rejected as being anticipated under 35 U.S.C. § 102(e) by Sekine et al. (U.S. Patent No. 5,622,888); and

(2) whether the Examiner has properly withdrawn Claims 25-27 from examination.

VII. GROUPING OF CLAIMS

The pending claims do not stand or fall together. Rather, Appellant has argued below the patentability of Claims 6-12 and 29-30 and has separately argued the patentability of Claims 29-30. Accordingly, Claims 6-12 form one group and Claims 29-30 form a second group for which separate grounds of patentability are argued below.

Appellant reserves the right to separately argue, in subsequent continuing applications, the patentability of various dependent features not addressed herein.

VIII. APPELLANT'S ARGUMENT

A. Claims 6-12 Are Patentable Over Sekine et al.

The Examiner has rejected Claims 6-12 as being anticipated under 35 U.S.C. § 102(e) by Sekine et al. (U.S. Patent No. 5,622,888).

Appellant traverses the rejection on the basis of the fact that the sole reference employed in the rejection fails to teach or suggest the ***sequence*** recited in independent Claim 6. It is well established that the Examiner cannot merely provide all of the elements of Appellant's claim in the prior art, but rather must show that the prior art teaches or suggests these elements ***in the manner claimed***. "[R]ejecting patents solely by finding prior art corollaries for the claimed elements would permit an examiner to use the claimed invention itself as a blueprint for piecing together elements in the prior art to defeat the patentability of the claimed invention." In re Rouffet, 47 U.S.P.Q. 2d 1453, 1457 (Fed. Cir. 1998). In the present case, the Examiner employs Sekine's teaching of a substitution reaction (substituting silicon atoms for metal atoms), in which the substitution reaction itself forms the rugged surface, whereas Appellant has specifically recited a sequence in which the silicon is first made rugged and subsequently replaced by metal. Sekine simply does not teach this sequence.

The Examiner supports her rejections by stating that after making the silicon electrode rugged (pointing to element 73a in FIG. 3(b)), Sekine teaches replacing the silicon in the silicon structure with a metal to thereby form a textured metal electrode (pointing to element 73b of FIG. 3(b)). Additionally, the Examiner points to Sekine's teaching of the rugged structure silicon atoms comprising HSG (pointing to Col. 1, ll. 55-57 of Sekine).

Appellant submits that the Examiner bases the rejections upon an incorrect understanding of Sekine. Contrary to the Examiner's assertions, Sekine clearly teaches depositing "a phosphorous-doped amorphous polysilicon layer" which is subsequently "patterned into a lower capacitive electrode 2 by lithography/etching." Sekine at Col. 5, ll. 10-14. Sekine does not teach or suggest that the lower capacitive electrode 2 is rugged, nor is it shown as such in FIG. 3(a).

Following patterning of the polysilicon layer that forms the capacitive electrode 2, a substitution reaction is conducted, "thereby replacing a surface layer of the phosphorous-doped amorphous polysilicon with a ***tungsten layer 73a*** as shown in FIG. 3(b)." Col. 5, ll. 25-27. While the Examiner states that layer 73a represents a rugged silicon layer, the specification of Sekine clearly indicates that 73a is a tungsten layer. The Examiner is ***factually incorrect*** about whether 73a represents a silicon layer or a tungsten layer. It is only with the formation of the tungsten layer that any rugged surface is ever introduced in the teachings of Sekine. In other words, the embodiments of Sekine's invention do not include any rugged silicon structure prior to the substitution reaction that forms the rugged metal layer, contrary to the recitation of independent Claim 6 that the substitution reaction follows the formation of a rugged silicon structure.

Furthermore, both of the layers 73a and 73b are tungsten layers, not silicon layers. After the substitution reaction first introduces a rugged surface by formation of a rugged tungsten surface 73a, an additional tungsten layer is then deposited by a non-replacement reaction "so that a tungsten layer 73b is deposited on the tungsten layer 73a as shown in FIG. 3(b)." Sekine at Col. 5, ll. 42-47.

In summary, Sekine teaches first forming a polysilicon electrode 2 and does not teach that this polysilicon electrode 2 is rugged; a replacement reaction is performed on this silicon layer to form a rugged surface tungsten layer 73a; and a subsequent tungsten layer 73b is deposited on top of this first tungsten layer 73a. Sekine neither teaches nor suggests that the initial silicon layer should be made rugged prior to forming the replacement reaction. In fact, it is the replacement

reaction itself that produces a rugged surface; Sekine teaches that at the time of the replacement reaction:

> the nuclear generation density of tungsten varies due to the partial pressure of WF_6 and the concentration of impurities in the phosphorous doped amorphous polysilicon. Specifically, since the nuclear generation of tungsten decreases as the concentration of impurities in the polycrystalline silicon is lower and the partial pressure of WF_6 as defined by the above formula is lower, crystalline particles of tungsten are produced in a minute coarse distribution.

Sekine at Col. 5, II. 30-35.

Thus, it is only during the process of the substitution reaction that any rugged surface is defined. Thus, the Examiner has incorrectly identified tungsten layer 73a as a rugged silicon layer, and nowhere does the reference teach or suggest a sequence in which a rugged silicon structure is first formed, and a substitution reaction performed thereafter.

The Examiner's erroneous finding that a rugged silicon structure pre-exists at the time of the substitution reaction is further underscored by the unwarranted and unmotivated combination with the Background teachings of Sekine, as discussed in more detail in the next argument section.

Accordingly, Appellant respectfully submits that Sekine does not teach or suggest each and every element of independent Claim 6 and therefore fails to anticipate it or render it obvious. Dependent Claims 7-12 each depend from independent Claim 6 and recite further distinguishing features of particular utility. Accordingly, Appellant respectfully submits that Claims 7-12 are also allowable over the art of record.

B. <u>Claims 29-30 Are Patentable Over Sekine et al.</u>

Initially, Appellant points out that Claims 29-30 depend from independent Claim 6. Therefore, these claims contain all the features and limitations of independent Claim 6 and the arguments above, based on the Examiner's factual misunderstanding of the process in Sekine, apply equally to Claims 29-30.

Furthermore, Claims 29-30 recite that the silicon rugged structure "comprises a hemispherically grained silicon structure." In finding these claims anticipated by Sekine, the

Examiner states that Sekine teaches "the rugged structure of silicon atoms comprises HGS [Sic:HSG] (Col. 1, lines : 55-57)." Final Office Action at page 4.

Appellant submits that the Examiner points to the ***Background*** teachings of Sekine, and not the preferred embodiment of Sekine. Although the Examiner styles the rejection as one of anticipation, in fact the rejection represents an unmotivated combination of Background teachings and preferred embodiment teachings. Nowhere does Sekine teach or suggest combining the Background teachings of HSG silicon with the preferred embodiment wherein electrode is ruggedized by the substitution reaction itself.

In fact, Sekine clearly ***teaches away*** from the use of HSG silicon as undesirable. In particular, Sekine refers to a prior art process in which tungsten is ***deposited*** directly on HSG silicon, not a process in which a substitution reaction is used. Furthermore, Sekine teaches that this prior art process in which HSG silicon is formed and followed by metal deposition is undesirable because it results in flattening and therefore loss of the increased surface area:

> Recently there has been developed and put to use a technique to roughen a surface of such phosphorous-doped polysilicon by way of HSG until the surface thereof is almost doubled.
>
> If, however, a tungsten film is deposited to a thickness of at least 100 nm on the roughened surface of the phosphorous-doped polysilicon, the roughened surface of the phosphorous-doped polysilicon will be flattened, eliminating the increase of the surface area thereof . . . Therefore the surface of the phosphorous-doped polysilicon is no longer rough, but made flat and smooth, and, as a result, does not have the increased surface area.

Sekine at Col. 1, l. 34 to Col. 2, l. 3.

Therefore, the Examiner has short-circuited the requirement to show a motivation to combine the two separate teachings of Sekine by presenting the rejection as one of anticipation. If properly dealt with as an obviousness rejection, it is clear that the combination is unfair. The Examiner attempts to combine the Background teachings of Sekine (HSG, which Sekine itself teaches away from), with the preferred embodiment of Sekine, in which no HSG silicon formation is taught or suggested.

Accordingly, Appellant submits that dependent Claims 29 and 30 are patentable over Sekine because Sekine does not teach or suggest the recited sequence of first forming a rugged

silicon surface and subsequently performing a substitution reaction, as pointed out in argument section A., above, and for the additional reason that there is no teaching or suggestion within Sekine to employ the substitution reaction in combination with the use of HSG silicon.

C. Restriction Of Claims 25-27 Is Unfair

During prosecution, Appellant added Claims 25-27 (along with Claim 28, which is not at issue in the present appeal). That amendment was entered. However, the Examiner stated that Claims 25-27 constitute a separate species because they require forming a second electrode and a dielectric over the rugged surface of the substrate. Furthermore, the Examiner states that "since Applicant has received an action on the merits for the originally-presented invention, this invention has been constructively elected by original presentation for prosecution on the merits."

Appellant objects to this finding. Independent Claim 25 is essentially the same as independent Claim 20, which was originally included ***by the Examiner herself*** in Group II along with Claims 6-12 in a Restriction Requirement mailed from the Office on June 19, 2001. (Note that this restriction requirement erroneously included Claims 13-19, which had already been cancelled by preliminary amendment). Independent Claim 20 was examined by the Examiner and rejected several times. Independent Claim 20 was amended first by preliminary amendment on even date with the filing of the present application, second by an amendment dated December 19, 2002 and thirdly by an amendment dated June 27, 2003. This last amendment, which narrowed the claim by adding the element for forming a silicon electrode structure on the substrate and also adding language with respect to the formation of the metal electrode "by replacing silicon in the silicon electrode structure with metal," was refused entry by the Examiner in an Advisory Action dated June 29, 2003. That same Advisory Action indicated that Claims 6-12 were allowed. Accordingly, Appellant, in order to speed prosecution of the present case, voluntarily cancelled the rejected Claims 20-24. The Examiner then changed her mind in view of a new reference (Sekine) and rejected the previously allowed Claims 6-12.

In view of the new rejection of previously allowed claims, Appellants sought to reintroduce cancelled Claim 20 in the form of Claim 25 by an amendment dated December 15, 2003. Independent Claim 25 is essentially a narrowed form of Claim 20 as Appellant had attempted to amend it previously on June 27, 2003. In fact, new Claim 25 is identical to the form of Claim 20 in the amendment offered on June 27, 2003 with the sole exception that the word

"rugged" as inserted and the words "after forming the rugged silicon electrode" were added. Thus, Claim 25 represents an amendment to original Claim 20 (cancelled only to gain quick allowance in view of previously indicated allowability) narrowed by the following amendment:

> 25. (Withdrawn) A method of forming an integrated circuit capacitor on a substrate, the method comprising:
> forming a rugged silicon electrode structure on the substrate;
> forming a metal electrode having a rugged surface on the substrate after forming the rugged silicon electrode by replacing silicon in the rugged silicon electrode structure with metal;
> covering said rugged surface with a dielectric; and
> covering said dielectric with a second electrode.

This added language is the same language that was simultaneously introduced by amendment to independent Claim 6.

Accordingly, Appellant submits that it is patently unfair to now refuse examination of Claim 25, when it is simply a narrowed form of original Claim 20. Furthermore, Claim 20 was only cancelled voluntarily by Appellant in view of the previously indicated allowance of Claims 6-12, which allowance the Examiner later withdrew.

Appellant submits that it is unfair to now disallow re-entry of these claims into the case. Furthermore, its restriction at this point does not comply with 37 C.F.R. § 1.142(b) and M.P.E.P. § 821.03, and is also inconsistent with the Examiner's own original Restriction Requirement.

Accordingly, Appellant respectfully requests reinstatement of Claims 25-27 and examination thereof.

Furthermore, Appellant submits that independent Claim 25 recites the same sequence as Claim 6, requiring formation of a rugged silicon electrode structure to precede a formation of a rugged metal surface by replacement reaction that replaces silicon in the rugged silicon structure with metal. Accordingly, Appellant submits that Claims 25-27 are patentable for the same reasons set forth hereinabove with respect to Claim 6. Additionally, Claim 26 recites "providing a hemispherical grain silicon morphology" and so the additional arguments above with respect to Claims 29-30 also apply to Claim 26, which is therefore separately argued for patentability.

D. Conclusion

In view of the foregoing arguments, Appellant respectfully submits that Claims 6-12 and 29-30 are patentable over Sekine et al. Furthermore, Appellant respectfully requests reinstatement of Claims 25-27 and allowance for the same reasons.

IX. APPENDIX A

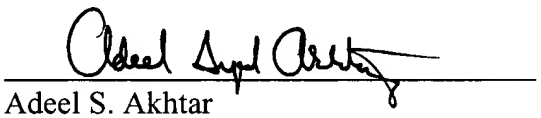
Attached hereto as Appendix A is a copy of the finally rejected claims in the present case as well as the withdrawn claims for which reinstatement is sought.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

KNOBBE, MARTENS, OLSON & BEAR, LLP

Dated: September 21, 2004

By: 

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APPENDIX A
(Claims as finally rejected)

1. – 5. (Withdrawn and Not Contested).

6. (Previously Presented) A process for fabricating a metal-insulator-metal capacitor on a semiconductor wafer comprising the steps of:

forming a silicon electrode structure on the semiconductor wafer;

making the silicon electrode structure rugged; and

after making the silicon electrode rugged, replacing the silicon in the rugged silicon electrode structure with a metal, thereby forming a rugged metal electrode.

7. (Previously Presented) The process of Claim 6, further comprising covering the rugged metal electrode with a dielectric layer having a high dielectric constant.

8. (Original) The process of Claim 7, further comprising covering the dielectric layer with a metal layer.

9. (Previously Presented) The process of Claim 6, wherein the step of replacing the silicon in the silicon electrode structure comprises forming a boundary layer on the silicon electrode structure, exposing the silicon electrode structure to a refractory metal-halide complex, and removing the boundary layer.

10. (Previously Presented) The process of Claim 9, wherein the boundary layer comprises a dielectric and the refractory metal-halide complex comprises WF_6.

11. (Original) The process of Claim 7, wherein the dielectric layer comprises a material selected from the group consisting of Ta_2O_5, $BaTiO_3$, $SrTiO_3$, $Ba_xSr_{1-x}TiO_3$, and $PbZr_xTi_{1-x}O_3$.

12. (Original) The process of Claim 8, wherein the metal layer comprises titanium.

13.-24. (Cancelled)

25. (Withdrawn and Reinstatement Sought) A method of forming an integrated circuit capacitor on a substrate, the method comprising:

forming a rugged silicon electrode structure on the substrate;

forming a metal electrode having a rugged surface on the substrate after forming the rugged silicon electrode by replacing silicon in the rugged silicon electrode structure with metal;

covering said rugged surface with a dielectric; and

covering said dielectric with a second electrode.

26. (Withdrawn and Reinstatement Sought) The method of Claim 25, wherein forming the metal electrode comprises providing a hemispherical grain silicon morphology.

27. (Withdrawn and Reinstatement Sought) The method of Claim 25, wherein forming the metal electrode comprises forming a rugged silicon layer and converting the silicon layer to metal.

28. (Withdrawn and Not Contested)

29. (Previously Presented) The process of Claim 6, wherein making the silicon electrode structure rugged comprises seeding and annealing to form a hemispherically grained silicon layer.

30. (Previously Presented) The process of Claim 6, wherein the rugged silicon electrode structure comprises a hemispherical grain morphology.

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